WE CLAIM:

1. An atherectomy device, comprising:

a device tip having a tip front face and a tip rear face;

a piezoelectric element (PZE) having a PZE front face and a PZE rear face, wherein said PZE front face is fixedly attached to said tip rear face;

means for energizing said PZE; and

a flexible shaft attached to said PZE for positioning said PZE to a position within the vasculature for removing arterial plaque.

2. The device of claim 1, wherein said device tip comprises a conical shape.

3. The device of claim 1, wherein said flexible shaft comprises a lumen for passage of a guidewire.

4. The device of claim 3, wherein said device tip comprises an opening for passage of said guidewire.

5. The device of claim 4, wherein said opening is centered on said device tip.

6. The device of claim 4, wherein said opening is off-center of said device tip, wherein the area of said arterial plaque under treatment may be increased by rotating said device tip around said guide wire.

7. The device of claim 1, further comprising a backing layer having a backing layer front face and a backing layer rear face, wherein said backing layer front face is connected to said PZE rear face, wherein said backing layer rear face is connected to said flexible shaft.

8. The device of claim 1, wherein said means for energizing said PZE comprises a first electrical lead connected to said PZE front face and a second electrical lead connected to said PZE rear face and an electrical source operatively connected to said first electrical lead and said second electrical lead.

9. The device of claim 8, wherein said PZE front face comprises a conductive coating electrically connected to said first electrical lead.

10. The device of claim 8, wherein said PZE rear face comprises a conductive coating electrically connected to said second electrical lead.

11. The device of claim 8, wherein said PZE front face comprises a first conductive coating electrically connected to said first electrical lead,

wherein said PZE rear face comprises a second conductive coating electrically connected to said second electrical lead.

12. The device of claim 1, wherein said first conductive coating and said second conductive coating comprise material selected from the group consisting of silver, gold and conductive epoxies.

13. The device of claim 1, wherein said PZE comprises piezoelectric material.

14. The device of claim 13, wherein said piezoelectric material is selected from the group consisting of lead zirconate titanate, polyvinylidine difluoride, LiNb and quartz.

15. The device of claim 8, wherein said electrical source is configured to provide continuous energy to said PZE to produce continuous ultrasound from said PZE.

16. The device of claim 8, wherein said electrical source is configured to provide pulsed energy to said PZE to produce pulsed ultrasound from said PZE.

17. The device of claim 1, wherein said device tip comprises an angled surface having an angle selected to couple ultrasound energy into said plaque.

18. The device of claim 3, wherein said flexible shaft has adequate stiffness to allow a user to push said device tip along said guidewire.

19. The device of claim 1, wherein said PZE comprises a material and a thickness that are selected for a desired operating frequency of said PZE.

20. The device of claim 1, wherein said device tip is roughened to increase friction and enhance plaque emulsification.

21. The device of claim 1, wherein said tip front face is corrugated with grooves that spiral inward providing a breaking of axial symmetry that enhances conversion of ultrasound waves from said PZE into shear and torsion waves.

22. The device of claim 2, wherein said conical shape comprises an cone angle that is between 60 and 120 degrees with respect to said arterial plaque.

23. The device of claim 1, wherein said device tip comprises a diameter within a range from 1 mm to 10 mm.

24. The device of claim 7, wherein said backing layer comprises a material and thickness that are selected to optimize the ultrasound energy transmitted in the forward direction.

25. The device of claim 7, wherein said backing layer comprises material selected from the group consisting of glass, metal, hard polymer and composites (e.g., graphite composite, epoxy resin and tungsten powder).

26. The device of claim 25, wherein said hard polymer is selected from the group consisting of polyurethane and Teflon®.

27. The device of claim 25, wherein said composites are selected from the group consisting of graphite composite, epoxy resin and tungsten powder.

28. The device of claim 1, further comprising a catheter that sheaths said device tip.

29. The device of claim 28, wherein said device tip may be pushed out of said catheter.

30. The device of claim 29, further comprising centering wires operatively connected between said device tip and said flexible shaft, wherein said centering wires deploy as said device tip is pushed out of said catheter, wherein said centering wire retract when the device tip is pulled back into said catheter.

31. The device of claim 1, further comprising a handle connected to said flexible shaft to enable a user to manipulate said device tip.

32. The device of claim 1, wherein said means for energizing said PZE comprises an electronic control unit that controls said PZE.

33. The device of claim 32, wherein said control unit includes means for controlling at least one operating parameter of said PZE, wherein said operating parameter is selected from the group consisting of energy applied to said PZE and operating frequency of said PZE.

34. A method for performing atherectomy, comprising:

inserting an atherectomy device into the vasculature near arterial plaque, wherein said device comprises:

a tip having a tip front face and a tip rear face;

a piezoelectric element (PZE) having a PZE front face and a PZE rear face, wherein said PZE front face is fixedly attached to said tip rear face;

means for energizing said PZE; and

a flexible shaft attached to said PZE for positioning said PZE to a position within said vasculature for removing arterial plaque; and

energizing said PZE to produce ultrasound waves.